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ABSTRACT

According to recent neurolinguistic theories and research, language and other analytic functions are located on the left side of the brain, while spatial and configurational abilities are located on the right side. However, there is some evidence that while learning a language requires the use of both hemispheres of the brain, the right hemisphere dominates in the ability to memorize Chinese characters. Several studies suggest that Chinese characters do not go through an initial process of phonetic recognition before being fully recognized, as may be the case with English writing. Instead they are interpreted directly for meaning, as pictures are, so that Chinese is often easier to recall than English. (Author/MSE)

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PSYCHOLINGUISTIC INTERFERENCE OF CHARACTERS IN READING CHINESE

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ABSTRACT

Chinese character recognition and recent neurolinguistic studies in Chinese character acquistion and reading. Particular attention is given to experiments and hypotheses concerning cerebral domination and reading and writing ability. According to these theories, language and other analytic functions are located on the left side of the brain, while spatial and configurational abilities are located on the right side. There is some evidence however, to support the claim that while learning a language requires the use of both hemispheres of the brain, the right hemisphere dominates in the ability to memorize Chinese characters. Several cited studies suggest that Chinese characters do not go through an initial process of phonetic recognition before being fully recognized, as may be the case with English writing, but instead are interpreted directly for meaning, as pictures are, so that Chinese is often easier to recall than English.

CONTENTS

LIST OF TABLES ii

LIST OF FIGURES iii

Chapter

I. Introduction 1

II. The Lateralization Effect in Reading Chinese Characters. .2

III. Aphasia Research and Its Implications for Left-right Hemisphere Functions 4

IV. Differences between Aphasia in English Speakers and Aphasia in Chinese Speakers 11

1. Aphasia 11

2. Areas of the Brain with Related Language Functions 12

3. Types of Aphasia and the Nature of the Deficits 12

4. Fluency vs Nonfluency 14

5. Boston Test Patterns for English Speaker's Aphasia 14

6. Rebabilitaion Success for English-Speaking Aphasic Patients 20

7. A Clinical Test for Chinese Speakers Who Experience Aphasia 21

V. Efficacy of Logographic Writing Systems for Memorization 26

1. American Children with Reading Problems can Easily Learn to Read English Represented by Chinese Characters 29

2. The Lateratization Effects 30

3. Differing Patterns of Memory 31

VI. Conclusion 32

LIST OF TABLES

Table

1. Comparison of English Aphasics..... 20

2. Therapeutic Effects of Aphasics 23

LIST OF FIGURES

Figure

1. Relation of Orthographies to Meaning 2

2. Diagram of the Areas of the Brain with Related Language Functions 13

3. Character-Picture Imitation Test (Sample Test Question) 24

PSYCHOLINGUISTIC INTERFERENCE OF CHARACTERS
IN
READING CHINESE

I. Introduction

Chinese writing is a system of visual symbols; in order to show that visual lateralization affects reading, this paper will consider three major questions in the study of reading Chinese characters from the viewpoint of experimental psychology. These are:

1. The lateralization effect in reading Chinese characters.
2. Differences between aphasia in English speakers and aphasia in Chinese speakers.
3. The Efficacy of logographic writing systems for memorization.

Explicit treatment of these topics has been reported in a series of controlled research projects. Literature about aphasia and experiments in the limiting of cerebral lateralization gives evidence for lateralization in language and perception. In addition the recognition of logographic symbols by recovered aphasics can give information on a person's capacity for learning Chinese characters. Therefore, it is not difficult to develop test hypotheses and experiments which illuminate the learning

of Chinese characters.

This paper will follow these three questions as above, giving some evidence to support the interpretation that learning a language, including speech and recognizing of symbols, may be related to fundtions of the whole brain, but that the right hemisphere dominates in the ability to memorize Chinese characters.

II. The lateralization Effect in Reading Chinese Characters

English and Chinese writing systems convey meaning in quite diifferent ways. English uses a phonologically based writing system while Chinese uses a logographic system. Borrowing fom Liu (1978, p. 154) we diagram the two defferent paths which readers must utilize to obtain meaning as follows.

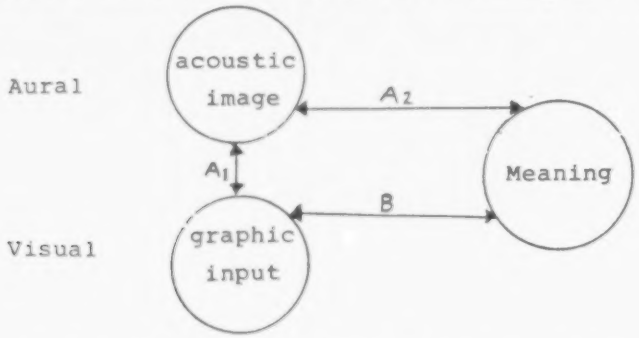


Figure 1: Relation of Orthographies to Meaning. (Liu, 1978, p. 154).

Path A, the path followed by an English reader associate the graphic input with a mediated process, such as word identification through some acoustic image. The meaning of the graph is assessed via the sound image, which serves as an intermediary. Path B, the path used by a chinese reader leads

directly from the graph to the meaning without an intermediary. Japanese writing interestingly uses both path A for kana (phonetic writing transcription) and path B for kanji (borrowed Chinese characters used for writing in Japan).

The logical question that follows from this diagram is whether or not these different path ways have a physiological reflection. In other words, does the brain use different mechanisms or areas to process logographic and phonological writing? As the results cited below will show, the answer to this question is yes. English writing and by extension phonologically based writing systems in general are processed in the left hemisphere of the brain. Chinese writing is processed in the right hemisphere.

This result is consistent with what is known of the way in which the brain functions in general are divided. As Geschwind (1979) in his Specializations of the Human Brain said 'Certain higher faculties, such as language, depend on specialized regions in the human brain. On a larger scale the two cerebral hemispheres are specialized for different kinds of mental activity' (p. 110). Kimura (1973) found in a dichotic listening experiment that speech sounds that were received in the left hemisphere were processed quicker and more accurately than sounds precessed in the right hemisphere.

In contrast, Geschwind said:

> There is reason to believe the right side of the brain is more important for the perception of melodies, one item of evidence being the ease with which aphasic patients with left-hemisphere damage can sing. The perception and analysis of nonverbal visual patterns such as perspective drawings, is largely a function of the right hemisphere (p. 141).

Young, Bion, and Ellis (1980) report in A Model of Laterality Effects for Picture and Word Naming that large right visual hemifield (RVF) superiorities were found to arise from both first and second reports for naming nouns and consonant-vowel-consonant (CVC) nonwords. Drawing and picturable nouns, however, produced only a small RVF superiority arising entirely from subjects' second reports (p. 54). The results of the experiments, according to the proposed model, arise from the extent to which the right hemisphere is able to process different types of visual stimuli. Pictures and simple nouns can be identified by the right hemisphere, and produce an RVF superiority arising from subjects' second reports only.

Aphasia Research and Its Implications for Left-Right Hemisphere Functions

Solid evidence for the differing functions of the left and right hemispheres can also be found in recent work with aphisic patients. First we will consider the work of Wapner and Gardner (1981). They conducted a unitary and

pluralistic experiment using fifty-seven patients who had organic brain damage. The hypotheses considered were: a unitary school of thought that views all symbolic competences as closely related, and a rival (pluralistic) approach that emphasizes the relative differences among modes of symbolic processing. To study these competing hypotheses, matched groups of left-and right-hemisphere brain damaged patients were given a visual symbol-recognition test. Subjects were required to choose the correctly depicted symbol among a set of four. The results do not strongly support the 'unitary' hypothesis. Instead the symbol system is expressed as a continuum: 'relatively linguistic symbol systems prove challenging for left-hemisphere patients, relatively nonlinguistic systems pose comparable difficulties for right-hemisphere brain damaged patients' (p. 303). Contrary to the hypothesis, the processing of numerical symbols poses special difficulty for right-hemisphere brain damaged patients. Performance on trademarks--items which can be processed linguistically or nonlinguistically--suggests that brain damaged patients with differing impairmants will process the same physical stimuli with different strategies.

It was further hypothesized that the right-hemisphere patients' decoding of visual symbols would benefit from the availability of linguistic cues (e.g. words, alphabetic trademarks), whereas marked difficulties would be exhibited with reference to those visual symbols which lack linguistic information (e.g. depicted objects, pictorial trademarks). In contrast, aphasic subjects were expected to demonstrate greater facility with picturable symbols than with symbols requiring linguistic processing. In addition, it was hypothesized that left- and right-hemisphere patients would exhibit different strategies in the processing of symbols: right-hemisphere patients would utilize linguistic strategies whenever possible, left-hemisphere patients would give up these in favor of pictographic modes of identification.

Results of this experiment show that right-hemisphere damage patients achieved less success with purely pictorial trademarks than with logos composed of letters, while the opposite pattern was obtained among left-hemisphere damage patients. This finding also suggests that the two groups might be decoding certain symbols by different processes; given the option, the left-hemisphere group approaches trademarks as if they are pictorial symbols, while the right-hemisphere patients seek to process them as linguistic or

notational symbols (cf. Gardner et al., Sasanuma, 1975). This also supports the hypothesis that the right-hemisphere dominates in the ability to memorize Chinese characters.

Japanese language research provides some additional data. The Japanese language uses two types of nonalphabetic symbols, kana and kanji, in its writing system. Kana are phonetic symbols for syllables, and all Japanese words can be written in this form. However, usually only grammatical morphemes, adjectives, and function words are written in kana, while the lexical morphemes are written in kanji. Kanji are nonphonetic logographic symbols, which are the same as Chinese characters.

Two main approaches have been used to study the cerebal lateralization functions for processing Chinese characters. The first is to study the effects of brain lesions on reading behavior and thereby infer the psychological functions of the corresponding structures of the nervous system. This approach has been used by Sasanuma (1972, 1974 a, b, c, 1975) in several studies of Japanese aphasics. She has found that impairment of a phonetic-based orthography was accompanied by a syndrome known as Broca's aphasia, while logographic symbol impairment was characterized by word meaning aphasia. Another approach is to

use a visual half-field experimental paradigm with normal subjects. The dependent measures are identification accuracy scores and/or reaction time required for making a certain decision. With this paradigm, superior performance of the right hemisphere in recognition of logographic symbols has been reported by Hatta (1977) with Japanese subjects. He reported an experiment measuring recognition accuracy of kanji characters. Left visual field superiority was found for both high and low familiarity kanji characters, suggesting that kanji characters are processed in the right hemisphere. However, a similar experimental study was made of the visual lateralization effects with logographical symbols. Sasanuma, Itoh, Mori and Kobayashi (1977) have experimented with kana and kanji words tachistoscopically exposed in the left and right visual fields in normal right-handed subjects. They found counter-evidence, that there existed a significant RVF superiority for the recognition of kana words but a nonsignificant trend of LVF superiority of kanji.

The discrepancy between the results of Hatta and Sasanuma could possibly be explained by methodological difference in the two experiments. The Hatta experiments used either kana or kanji characters for individual subjects, whereas Sasanuma et al. presented a mixed list of kana and kanji to all subjects. It is possible that in

the Hatta study the hemisphere most appropriate for the task was primed to handle the stimuli. Furthermore, in the Sasanuma et al. study, subjects were asked to identify kana and kanji at the same time. Exposure to kana and kanji together may involve some phonetic recoding, and involve both hemispheres, thus reducing the LVF advantage, and making the data hard to interpret. More research is necessary to specify the locus of these differences. For the present, it suffices to conclude from all these experimental results that kana and kanji symbols are differentially processed with respect to laterality (Sasanuma at al., 1977).

Moving beyond these Japanese results, other experiments show clearly the different functions in cerebral lateralization for the recognition of Chinese characters.

Tzeng, Hung, and Garro (1978) asked Chinese subjects to read Chinese characters which contain phonetic components (Hsing-sheng) and characters which are pictographic in origin (Hsiang-Hsing .) Regardless of the type of characters, a definite and significant left visual field superiority in subjects' recognition performance was obtained, suggesting that both types of characters are processed first in the right hemisphere.

Tzeng and Wang (1983) conducted a T-scope experiment to prove that the way different languages reduce speech to script affects how visual information is processed in the brain. They have applied the visual half-field technique to study the process of word recognition in various scripts. The results are affirmative for our hypotheses here. For alphabetic scripts such as English and Spanish, an RVF superiority is consistently found, suggesting a greater involvement of functions in the left hemisphere. This RVF superiority obtains as well for scripts like Arabic and Hebrew, even though in these cases the letters run right to left across the page. In contrast to these scripts, an LVF advantage is observed when they present Chinese readers with single logographs, suggesting that their right hemisphere is more active (Tzeng and Wang, 1983, p. 241). This result proves that different neurolinguistic pathways are used to transform different scripts into different hemispheres.

In summary, in the study of reading Chinese characters from the viewpoint of experimental psychology, one can find that the function of brain lateralization, in the recognition of a Chinese character, may be dominated by the right hemisphere, but that maximum speech ability is dominated by the left hemisphere. That means that to learn or to memo-

rize those pictorial like symbols in the cognitive process, based on the above results obtained in Japan and at the Tzeng et al. laboratory (U.C. Riverside), it is clear that the dominance is in the right hemisphere.

Differences between Aphasia in English Speakers and Aphasia In Chinese Speakers

Aphasia

Unilateral cerebral damage to either the left or the right hemisphere can result in acquired language disorders. These language disorders can cause the patients to have difficulties in the comprehension and production of spoken and written language. Aphasia, which is defined as a 'linguistic deficit which causes... difficulty in the comprehension and/or formulation of language symbols' (Halpern, 1972), is one such disorder, usually associated with left hemisphere damage. The person with right hemisphere damage may look and act normal on casual observation. The changes in behavior that occur are generally not dramatic and can be dismissed as personality changes, confusion or dementia (Brookshire, 1978). In many instances, the patient's command of grammar and of sound structure seem unchanged, but the relationship between his knowledge of the world and his use of language is impaired. When aphasia results from a cerebrovascular accident (CVA)

or stroke, there is general agreement that it may consist of varying degrees of impairment to linguistic performance. These variations are usually influenced by the location and extent of brain damage (Goodglass and Kaplan, 1972).

Areas of the brain with related language functions

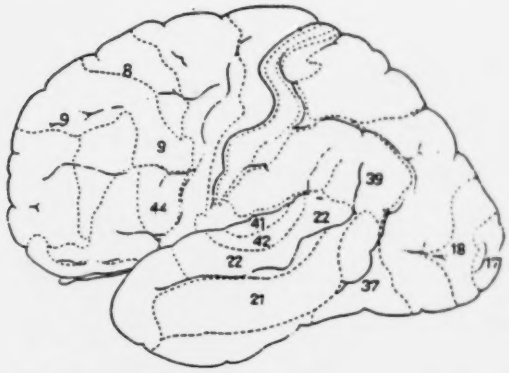
Buckingham (1982) gave a diagram of the areas of the brain with related language functions and language defects caused by destructive lesion. (Refer to the next page).

Normal language may depend on a complex interaction between sensory-motor skills, symbolic associations, and habitual syntactic patterns. These are controlled by the speaker's own developed intellectual capacity, and his or her desire to communicate. Aphasia is a disturbance of any or all of the skills, association and habits of spoken or written language, resulting from an injury to certain brain areas which are specialized for these functions. Not all disturbances are aphasic: some are caused by intellectual impairment, paralysis or poor coordination of the speech or writing muscles, or by poor vision or poor hearing. Aphasia patients often have these complicating disorders which makes it difficult for the doctors to analyze (Goodglass and Kaplan, 1972).

Types of aphasia and the nature of the deficits

There are many different symptoms in aphasia, which include extreme, selective disorders of auditory comprehe-

Figure 2 Diagram of the Areas of the Brain with Related Language Functions



(Buckingham, 1982)

Area	Function	Language Defects caused by Destructive Lesion
41 & 42 Wernicke'c Area	Recognition of spoken language	Auditory Verbal Agnosia
21 & 22	Recall and interpretation of spoken language	Loss of Verbal Recall
44 Broca's Area	Memory of motor patterns of speech	Motor Aphasia
37	Recall of names and words; language formulation	Anomia Amnesic Aphasia
39 Angular Gyrus	Symbols for reading, writing and arithmetic (letters and numbers)	Alexia Agraphia (Spelling) Acalculia
8 & 9 Exner's Writing Center	Knowledge of how to make movements of hands and fingers in writing	Agraphia (Motor)
17 & 18	Visual perception and recognition	Visual Verbal Agnosia without agraphia (caused by subcortical lesion between 17 and 39)

sion, object-naming, articulation, reading or repetition. Most doctors observe and report the same individual component deficits and also the same common clusters of deficits (that is the major aphasic syndromes), although they often use different names for these deficits, based on their own theoretical biases. Since the purpose of this study is to distinguish the differences in aphasic symptoms between English speakers and Chinese speakers, the detailed specific deficits in aphasia are disregarded. Instead some of the general deficits in verbal comprehension, speech, reading, and writing are discussed in this section.

Fluency vs Nonfluency

According to the clinical analysis in Learning About Stroke (1982) there are two types of aphasia: receptive and expressive (also called fluent and nonfluent). In receptive aphasia, the individual can hear what is said but cannot understand the words. Neither language symbols nor written words make any sense. In expressive aphasia, the individual knows what he or she wants to say but cannot form words that have any meaning. The ability to write may also be impaired. In some cases, aphasia is both receptive and expressive. An aphasic patient may not be able to speak or to understand words, but his or her thinking may be perfectly normal.

Boston Test Patterns for English Speakers' Aphasia

Many soldiers in World War II had injuries to their brains, which resulted in aphasia problems. The Aphasia Research Center, and the Department of Neurology was established at Boston University to rehabilitate these patients. This center, with the Boston Veterans Administration Hospital, developed the Boston Diagnostic Aphasia Test to analyze different kinds of aphasia. According to different aphasic patients' syndromes in the Boston Test, aphasic patterns can be divided into the following conditions (Goodglass and Kaplan, 1972).

1. Broca's Aphasia (Nonfluent Aphasia):

Its essential characteristics are awkward articulation, restricted vocabulary, restriction of grammar to the simplest, most overlearned forms, and relative preservation of auditory comprehension. Written language follows the pattern of speech in that writing is usually at least as severely impaired as speech, while reading is only mildly affected. The patient may simplify difficult sounds (e.g. ts for ch ; p for pl), in addition to distorting other sounds (e.g. 'pelsil' for 'pencil').

In the Boston Test of a Broca's aphasic, the patient's listening and reading abilities are much higher than his or her speaking fluency. Also his control of the mechanics of writing rates a higher score than his actual writing of meaningful words.

2. Wernicke's Aphasia (Fluent Aphasia):

The critical features of this syndrome are impaired auditory comprehension and fluently articulated, but paraphasic speech. The impairment of auditory comprehension is evident even at the one-word level. The patient may be able to repeat the examiner's words verbatim; however, he is clueless as to the actual meaning of the word. At severe levels, auditory comprehension is zero, and paraphasic speech is so pervasive that the patient is unable to produce anything but meaningless jargon. Paraphasia may include both sound transpositions (literal paraphasia) and word substitutions (verbal paraphasia). In addition, word-finding difficulty is an almost constant feature of this disorder, while reading and writing are usually severely impaired as well. The grammar of these patients is often incorrect; they often use complex verb tenses, embedded subordinate clauses, and other complicated structures, but when they use this style of expression, people cannot understand them. Their syntax is, therefore, described as 'paragrammatic,' rather than 'agrammatic.'

In the Boston Test of Wernicke's aphasia , the patient's verbal fluency is very high, but his or her auditory comprehension, writing skills and reading comprehension are much lower.

3. Anomic Aphasia:

The major feature of anomia is the prominence of word-finding difficulty in the context of fluent, grammatically well-formed speech. It is different from Wernicke's aphasia; patients do not have literal and verbal paraphasia and their auditory comprehension is much better than the Wernicke aphasic's. They speak freely, using function words correctly, but do not use meaningful substance words, e.g. for 'I had an operation on my head,' one may say, 'I had one of them up there,' or, 'I had a thing done up where your hair is.'

In the Boston Test of anomic aphasic, the patient's verbal fluency and auditory comprehension are very good, but their reading comprehension and writing abilities are weak.

4. Conduction Aphasia:

This is also considered one of the 'fluent' aphasias; sometimes the victim's fluent utterances are of very short duration. In these cases, the patients are unlike Broca's aphasics; they usually produce well-articulated sequences of English phonemes and will use a variety of syntactic patterns with normal intonation. Their speech difficulty is in the proper choice and sequencing of their phonemes, so that literal paraphasia constantly interferes with production. In addition, errors with number repetition take the form of verbal paraphasia (word-substitution) rather than literal paraphasia. Reading and writing may vary over a wide range from patient to

patient. The patients are most sensitive to disturbances of written language; some patients read at a functional level and write as they speak.

In the Boston Test of a conductive aphasia, the patient's speaking fluency is very high and auditory comprehension is very good. Also reading comprehension is higher than writing ability.

5. Transcortical Sensory Aphasia:

Typical patients with this disorder do not automatically begin speaking. When someone talks to them, they can repeat what they hear and if someone asks them a question, they can answer in the same grammatical construction; often they merely repeat the words they hear. These patients are able to use long and complex sentences, but they cannot read or write.

In the Boston Test of a transcortical sensory aphasic, the patient's speaking ability is good, but his auditory comprehension is low. Neither reading nor writing ability is any good.

6. Alexia with Agraphia:

These patients have lost the ability to read and write. However, their speech and comprehension are completely exempt from impairment. They cannot match letters or words across styles of writing. Letter recognition is spared,

patients perform inconstantly with three- to four- letter primer words, and they cannot write letters from dictation or transcribe print into longhand, although slavish copying is usually possible. In mild cases, elementary writing is preserved but gross errors in spelling are common. In the effort of writing, the patient loses track of grammatical features and omits or misuses small words and inflectional endings.

From the result of the Boston Test, as in Broca's Aphasia, Wernicke's Aphasia, Anomic Aphasia, Conduction Aphasia, Transcortical Sensory Aphasia, and Alexia with Agraphia, one can see that in the following table of comparison (refer to the next page), aphasia in speakers of English generally causes more deficiency in patients' reading and writing abilities than in their speaking and listening abilities.

Some prominent phenomena in the Boston Test highlight the fact that reading with pictures and writing or drawing with pictures (that means pictoral representations of some real visible articles) can remain stored in an aphasic's right hemisphere, even though s/he has lost his/her speech ability.

TABLE 1

COMPARISON OF ENGLISH APHASICS

Aphasics	Abilities of			
	Listening	Speaking	Reading	Writing
Broca	V	X	O	X
Wernick	X	V	X	X
Anomic	V	V	X	X
Conduction	V	V	O	X
Transcortical Sensory	X	V	X	X
Alexia with Agraphia	V	V	X	X

(V): Good (O): Not good (X): Bad

Rehabilitation Success for English-Speaking Aphasic Patients

Some investigations have concluded that patients with different types of aphasic syndromes recover differently. Aphasiologists generally consider that the effects of aphasia rehabilitation are positive. However, the limits of spontaneous recovery and the relative influence of many variables on the outcome are still not definitive.

Lomas and Kertesz (1978) analyzed recovery patterns in 31 aphasic patients and found equal improvement on all language tasks for the patients who have good auditory comprehension.

Reivnang and Engvik (1980) concluded that the profile of linguistic impairment tended to be maintained during a 2-6-month period of rehabilitation. Half of the patients showed a global impairment, and half showed a pattern of specific impairment. The most significant improvement was noted in the patients' oral language and in the clinical rating of the patients' communication ability. Patients made only moderate improvement in writing. With regard to auditory comprehension, patients showed improvement in following commands, but there was not a significant comprehensive or conceptual improvement.

A Clinical Test for Chinese Speakers Who Experience Aphasia

The study of aphasia in Taiwan, Republic of China, only began around 1976; until then one could not find much material or data about aphasia. The Journal of Rehabilitation Medicine No. 6, 1978 included a research paper about aphasia: 'Preliminary Evaluation of Severity and Therapeutic Effects of Aphasics.' In this report, there are 100 aphasic subjects (89 males and 11 females, average age is 55.9 years). The research was conducted from July 1977 to April, 1978. The results generally are very similar to the American Boston Test. The deficiencies of aphasia patients in speaking and listening abilities are much less severe than in

their reading and writing abilities; but after ten months in rehabilitation, the results were quite different from the American aphasics.

Table 2 shows the preliminary evaluation of severity and therapeutic effects of those 100 aphasic patients. The mean of original deficits is 5.25; after ten months of treatment, the mean is 6.29, showing a mean improvement of 1.04. In the twelve different abilities tests, the most improved item is word-picture matching for reading; the least improved is verbal ability.

Two prominent phenomena are improvement in word-picture matching for reading and character-picture imitation for writing. Table 2 shows that the posttherapeutic performance is much higher for these abilities, with a mean improvement of 1.77 and 1.10. This phenomenon is quite different from the English speakers' recovery records that are discussed in the Boston study.

TABLE 2

THERAPEUTIC EFFECTS OF CHINESE APHASICS

Test Items	Prethera-peutic Mean	Postthera-peutic Mean	Improvement
Gesture Identification	7.17	8.25	1.08
Word-Picture Matching	7.04	8.81	1.77
Response Naming	6.42	7.33	0.91
Articulation Rating	5.70	6.66	0.96
Verbal Identification	5.16	6.41	1.25
Verbal Ability	5.04	5.88	0.44
Mathematic Ability	4.90	5.90	1.00
Sentence Reading	4.69	5.52	0.83
Character-Picture Imitation	4.59	5.69	1.10
Repetition of Sentences	4.58	5.26	0.68
Description of Article Uses	4.36	5.38	1.02
Original Writing	3.52	4.41	0.89
Total Mean	5.25	6.29	1.04

N=100 Level: from 1 to 10.

Source: Hsu, 1978, p.21

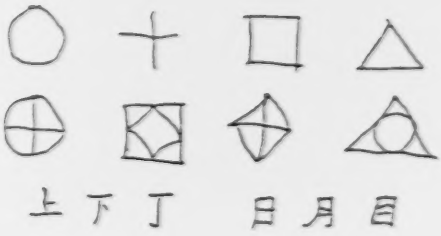
Figure 3 shows that many Chinese-speaking aphasia patients can recover their ability to draw figures and simple Chinese characters.

Figure 3 Character-picture Initation Test

(Sample Test Question)

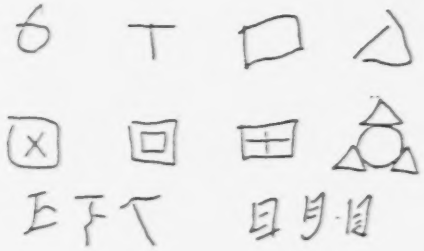
Standard:

(1) Perfect:

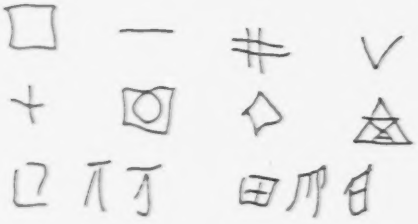


(2) Perfect but slow and corrected by themselves:

(3) Not correct but related:



(4) Not correct and unrelated, spontaneous writing:



Makita (1968) has reported that Janpanese children rarely have reading disabilities, in contrast to the situation in the United States. (This is usually attributed to the kana.) Erickson et al. (1972), however, provide data that the phonetic associations of kanji may be stronger than their graphic association.

Rozin et al. (1971) report success with students who have reading problems by teaching them to read English represented by Chinese characters. They suggest that the success of their program can be attributed to the fact that 'Chinese orthography maps directly into the meaningful unit' (Rozin, 1971, p. 1264). That is, the characters interpret into speech at the level of words rather than of phonemes. Therefore, they have come to the conclusion, that since logographic writing has printed forms that do not contain information about pronunciation, people must be able to read without speech recoding.

Efficacy of Logographic Writing Systems for Memorization

Memory is defined as the power of 'reproducing and identifying what has been learned or experienced' (Webster's Dictionary). Memory has many aspects. It requires the employment of more than one mechanism within the brain.

The nerve cells and nerve branches of some parts of the brain, or perhaps the synapses which join the branch of one

cell to the body of another cell, are altered by the preserve of different chemical neurotraus-mi-tters and by the passage of a stream of electrical potentials. This is what makes permanent patterns possible. This is the basis of all memory (Penfield and Roberts,1959, p. 228).

Some aphasics have a memory disorder which produces what appears to be a reading disability. These people cannot remember much of what they read so that by the time they have read through a short paragraph they have forgotten how it started. They cannot be interested in reading a book or even a newspaper article because they cannot retain enough to develop any continuity. There are some aphasics who read aloud perfectly, even with inflection at times, and who do not understand a single word they have read. These same words can be spoken to them by others and they may understand them well when they hear others say them, depending upon their ability to comprehend speech. Meaning, however, seems to be 'disconnected from the words ' when they read aloud or silently by themselves (Broida, 1979, p. 60-61).

Treatment for reading ability for aphasia patients involves the reading of actual pictures. Either objects or pictures of objects can be used with their names on cards. If action pictures are used when verbs are selected as the task, a verb is printed on the card instead of a noun. When

working on prepositions, the card can read simply: 'on the chair' or 'under the box.' The desired response is for the patient to place the cards according to what the words mean; for example, 'run,' by a picture of a boy running. When a patient becomes competent in enough parts of speech and sentences so that he can be introduced to paragraphs, his memory span must be carefully checked. If that seems to present no problem and he handles paragraphs well (therapists check for this competence with true and false questions presented after every paragraph), then he may be ready for short stories or newspaper articles (Broida, 1979, p. 66-67).

From Broida's explanation one can see that English reading ability which was lost in the memory of the aphasic can be recalled gradually by using objects or pictures of objects. Yet even if one can read the English words aloud perfectly, this does not prove s/he can understand what s/he reads. The words have to be related to some visible real objects or pictures in order to be restored to memory. On the other hand, in relation to Chinese characters there are at least five experiments that support the idea that the logographic writing system is more efficient for memorization than an alphabetic writing system: Rozin, et al.,(1971), Liberman et al., (1970), Bruce and Kinsbourne (1974), Hardyck, Tzeng, and Wang (1978), Tzeng and Wang (1983).

American Children with Reading Problems can Easily Learn to Read English Represented by Chinese Characters

Rozin, Poritsky, and Sotsky decided to teach a group of second-grade school children with serious reading problems some ideographic scripts. They summarize the reading disabilities of the children as follows:

> They (the children) had difficulty (i) in identifying words by initial or final sounds and (ii) in combining a sequence of letters into a known English word. Many of the children did not know all the alphabetic symbol-sound correspondences, which was surprising since they seemed to have excellent memories and could be taught arbitrary new symbols rather quickly (p. 1264).

They hypothesized that since logographic scripts such as Chinese characters have a one-to-one correspondence between image and meaning, children would not need to break down the word into phonemes in order to sound it out; consequently, they should be able to read Chinese with little dificulty. Their results support their hypothesis. They suggested that the success of their program can be attributed to the fact that Chinese characters 'map into speech at the level of words rather than of phonemes' (p. 1264).

Liberman gives further evidence both from speech output (articulation) and input (perception) that the alphabetic

unit or phoneme is unnatural or at least highly abstract (Liberman et al., 1970). But the Chinese logographic system, which 'maps directly into the meaningful units,' can be more efficient for memorization.

The Lateratization Effects

Bruce and Kinsbourne (1974) reported an experiment in which subjects were asked to remember complex visual forms. When done as a direct recognition task, left visual field-right hemisphere performance was slightly superior. However, when subjects had to perform the figure recognition task while retaining a list of words in memory, right visual field performance was superior.

Hardyck, Tzeng, and Wang (1978) conducted an experiment utilizing tachistoscopic presentation of verbal and spatial stimuli to visual half-fields. A basic premise is that verbal stimuli are processed in the left hemisphere and visuospatial stimuli in the right hemisphere. Stimuli presented exclusively in the right visual field serving the left hemisphere (RVF-LH) are processed more quickly and with fewer errors because they are received directly at a central verbal processor in the left hemisphere. Visuospatial problems such as pattern recognition are processed most effectively in the right hemisphere, allowing an advantage in processing speed and accuracy for stimuli

shown to the left visual field projecting to the right hemisphere (LVF-RH). The subjects were twenty fluent Chinese-English bilinguals (17 Chineses, 3 Americans), who were asked to compare semantic judgments of same-different across the two languages. The mean number of Chinese characters recalled was 5.40 for the right visual field-left hemisphere and 3.67 for the left visual field-right hemisphere. The corresponding values for English were 2.93 for the right visual field-left hemisphere and 2.40 for the left visual field-right hemisphere. Words most often recalled were those originally presented in the the right visual field-left hemisphere (p. 65).

In the Hardyck et al. experiment one can see very clearly that the number of Chinese characters is higher than the number of English words recalled by Chinese-English bilinguals. This is further evidence that the Chinese characters may be more efficient for memorization.

Differing Patterns of Memory

Tzeng and Wang (1983) reported a color experiment and a number experiments conducted by J.R. Stroop in 1935, which supports the contention that the relation between script and speech underlying all types of writing systems plays an important role in the reading process. 'A reader

of a particular script must assimilate the orthographic characteristics of that system.' That is to say, if the organization of the components of a logograph is important for understanding, then the reader has to pay special attention to the position of every element in the logograph. Therefore, the processing of logographs should involve more visual memory than the processing of alphabetic script.

VI. Conclusion

When viewed together the visual lateralization effect, the aphasic study, and the efficiency of memorization, all give evidence to show that speech abilities are dominated by the left hemisphere, and other adilities such as, music and picture recognition are dominated by the right hemisphere. The special characteristics of the Chinese language are tones and its pictographic characters. From the psycholinguistic point of view therefore, learning the Chinese language involves not only the left hemisphere for usual language learning functions, but also the right hemisphere for the picture-visual functions required to read Chinese writing. Because the Chinese character is a good example of ideographic or morphemic writing in which each symbol represents a unit meaning, it is more efficient for memorization than phonological orthographies like English. Therefore, in teaching Chinese as a second language, one has to emphasize the pictorial

feature; thus leading students to learn the Chinese written language efficiently.

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